Status of the B lifetime study with the lepton+D^0 events

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Satoru Uozumi

We are interested in measuring the B^+/B^0 lifetime and its ratio using lepton + $D^0(D^{*-})$ events.

This is basically a repetition of the Fumi's analysis in Run I (CDF4534).

The only difference is the trigger strategy (8GeV lepton in Run I, 4 GeV lepton + SVT track in Run II).

For the B^+/B^0 lifetime ratio, Run I analysis was not limited by systematics.
($B^+/B^0 = 1.110 + 0.056 \,^{+\,0.033}_{-\,0.030}$)
So we have a chance to improve the uncertainty in Run II.
Obviously the critical issue is the understanding the SVT trigger bias ...

Possible systematics from SVT bias

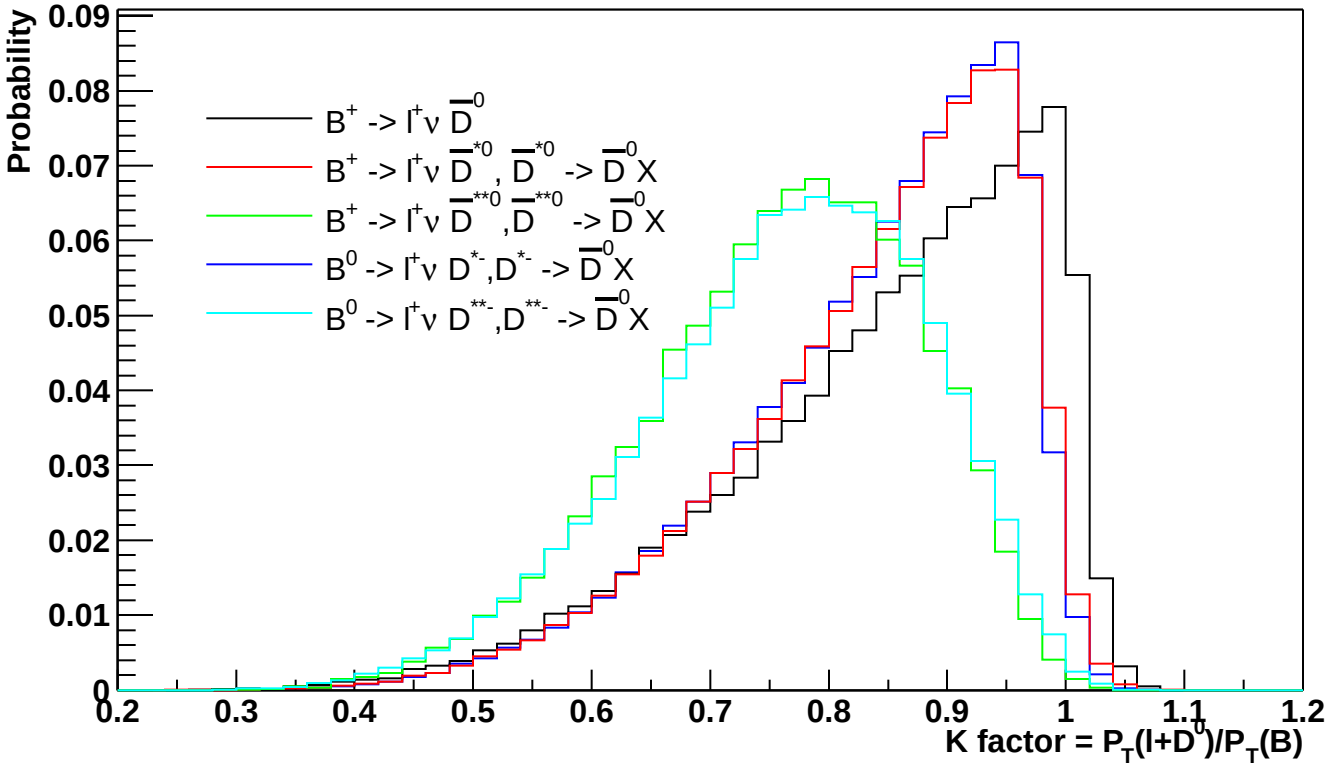
We cut on the SVT d0 as 120 μm < d0 < 1000 μm.

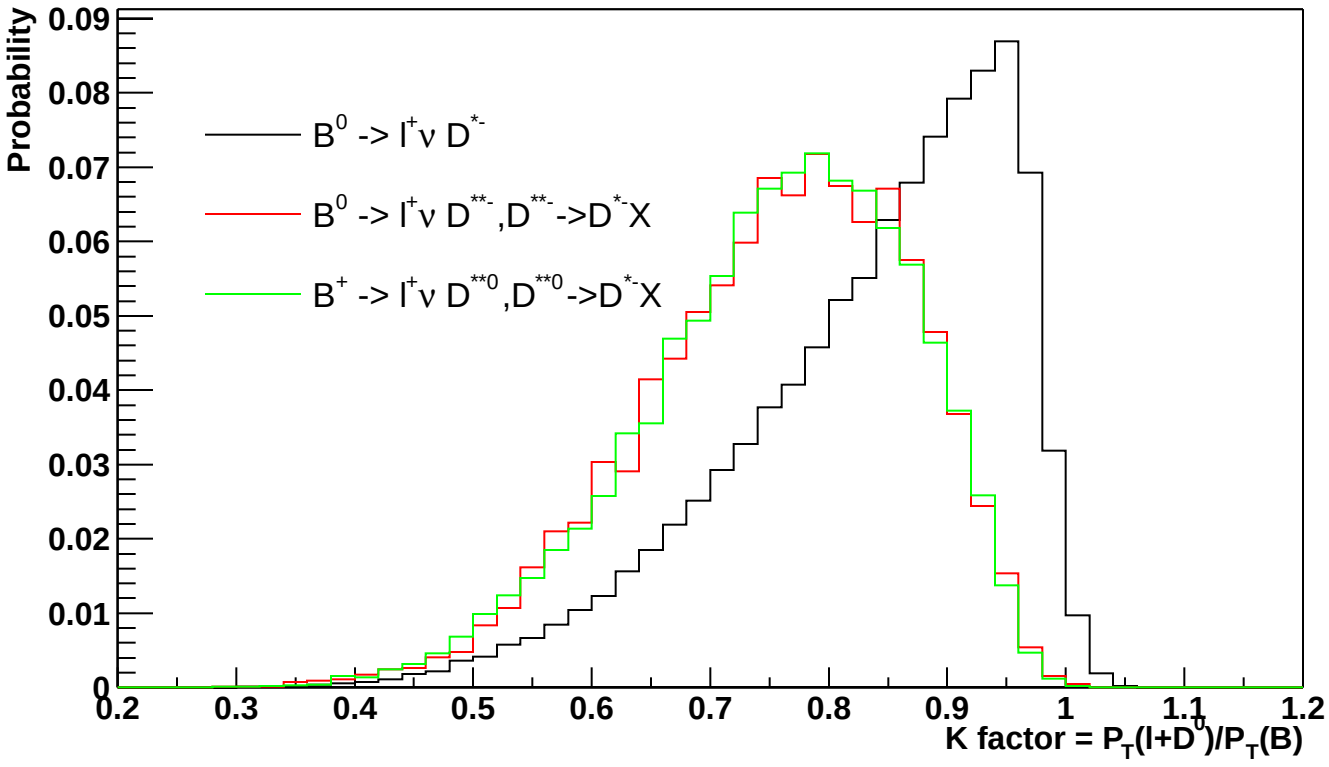
Basically the SVT bias curve for the lifetime can be obtained from the MC, but we need to know the SVT d0 resolution properly.
(note:The systematics from the SVT d0 resolution can be reduced by applying tighter d0 cut offline.)

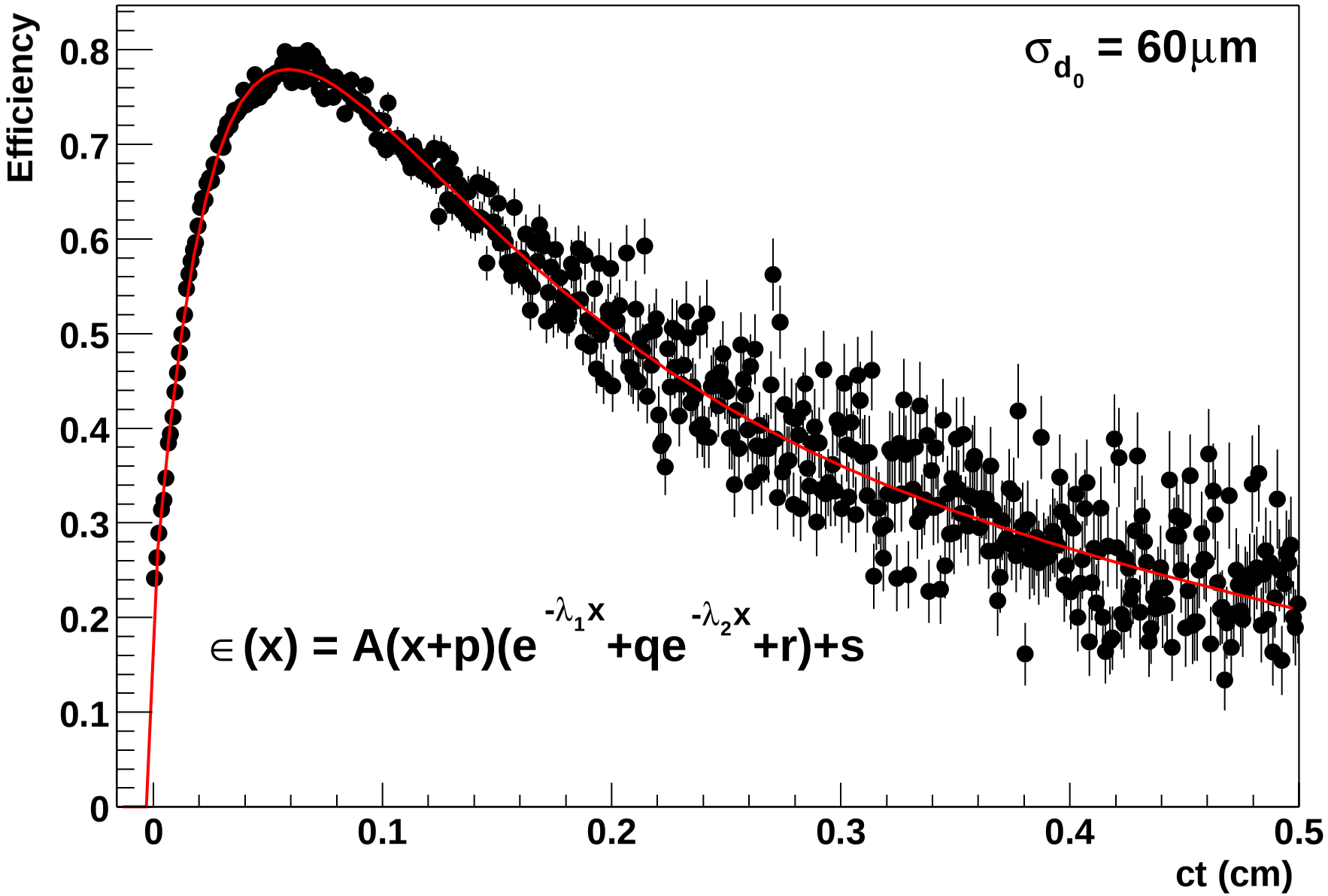
SVT tracking efficiency dependence for the SVT d0 gives further bias to the lifetime.

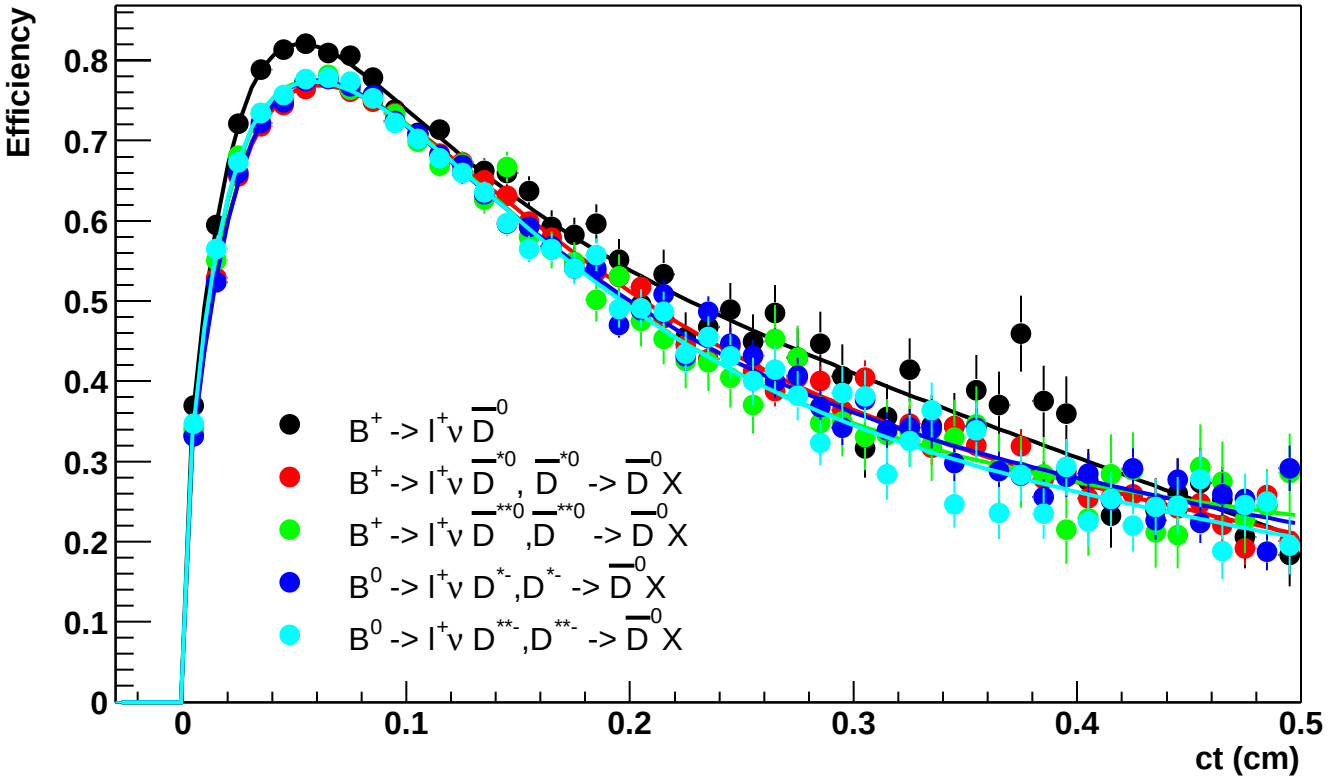
Also, SVT bias to the lifetime is different for the different decay modes.
This won't be cancelled even in the B^+/ B^0 lifetime ratio.

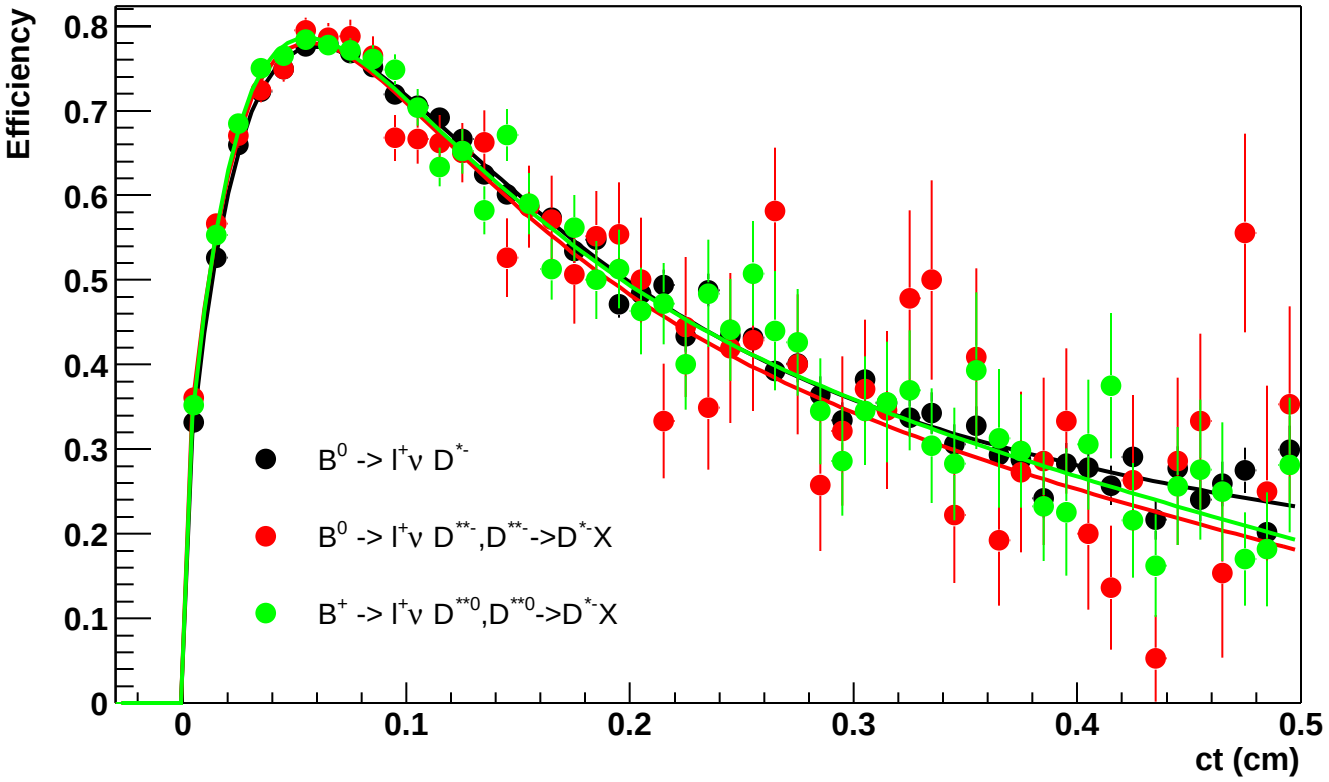
We are trying to understand these effect using a generator level MC (Bgenerator + QQ) and toy MC.
We estimate the K factor and SVT bias for the lifetime from generator level MC.
Then generate the toy MC events with it, and try to fit them and estimate possible systematics from the SVT bias.

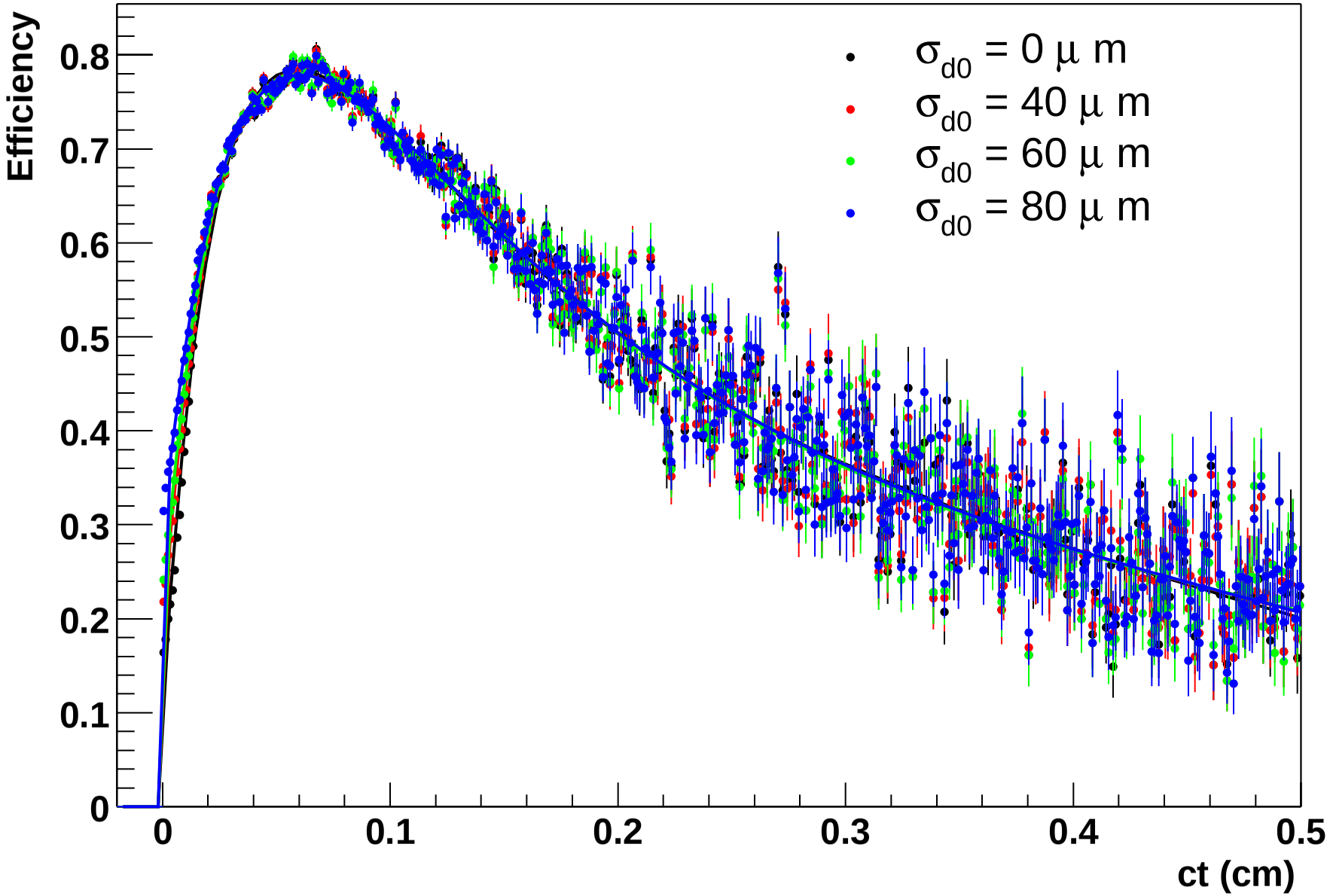

Probability
0.09
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
1.1
1.2
B+ -> l+ν D̄0
B+ -> l+ν D̄*0, D̄*0 -> D̄0X
B+ -> l+ν D̄**0, D̄**0 -> D̄0X
B0 -> l+ν D*-, D*- -> D̄0X
B0 -> l+ν D**-, D**- -> D̄0X
K factor = PT(l+D0)/PT(B)

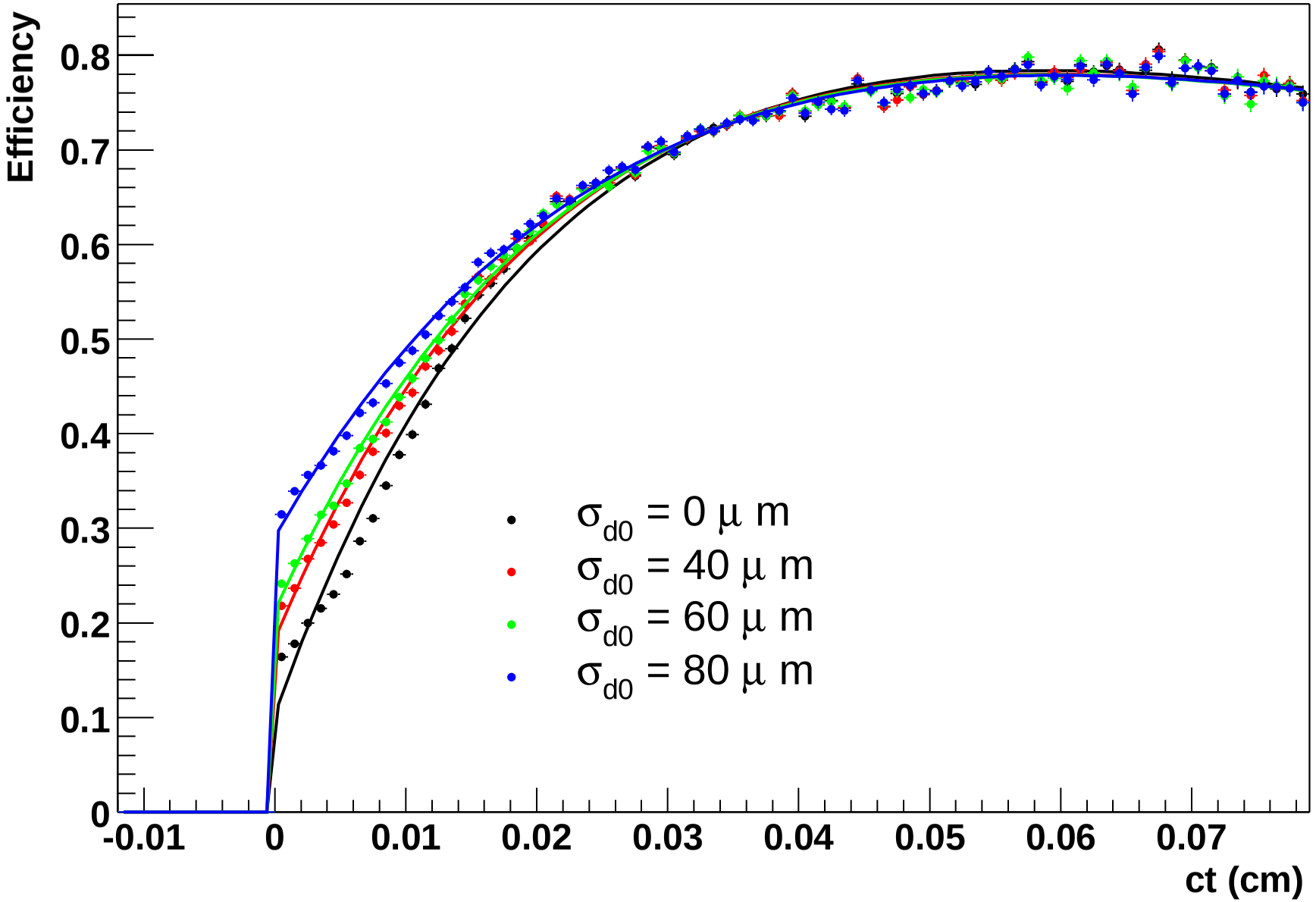

Probability
0.09
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
1.1
1.2
B0 -> l+ν D*-
B0 -> l+ν D**-, D**- -> D*-X
B+ -> l+ν D**0, D**0 -> D*-X
K factor = PT(l+D0)/PT(B)

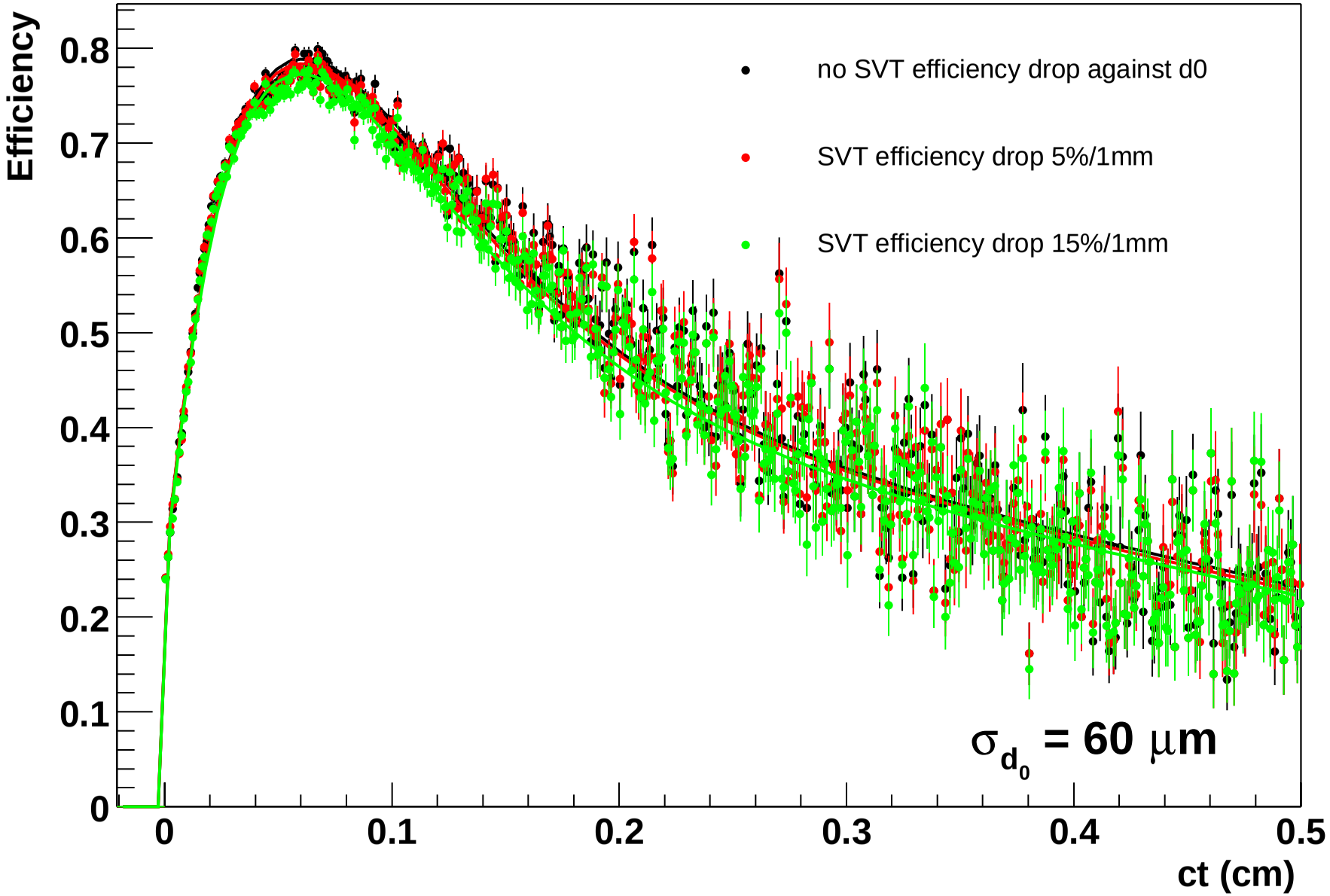

Efficiency
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
0
0.1
0.2
0.3
0.4
0.5
ct (cm)
σ_{d_0} = 60μm
$\in(x) = A(x+p)(e^{-\lambda_1 x} + qe^{-\lambda_2 x} + r) + s$

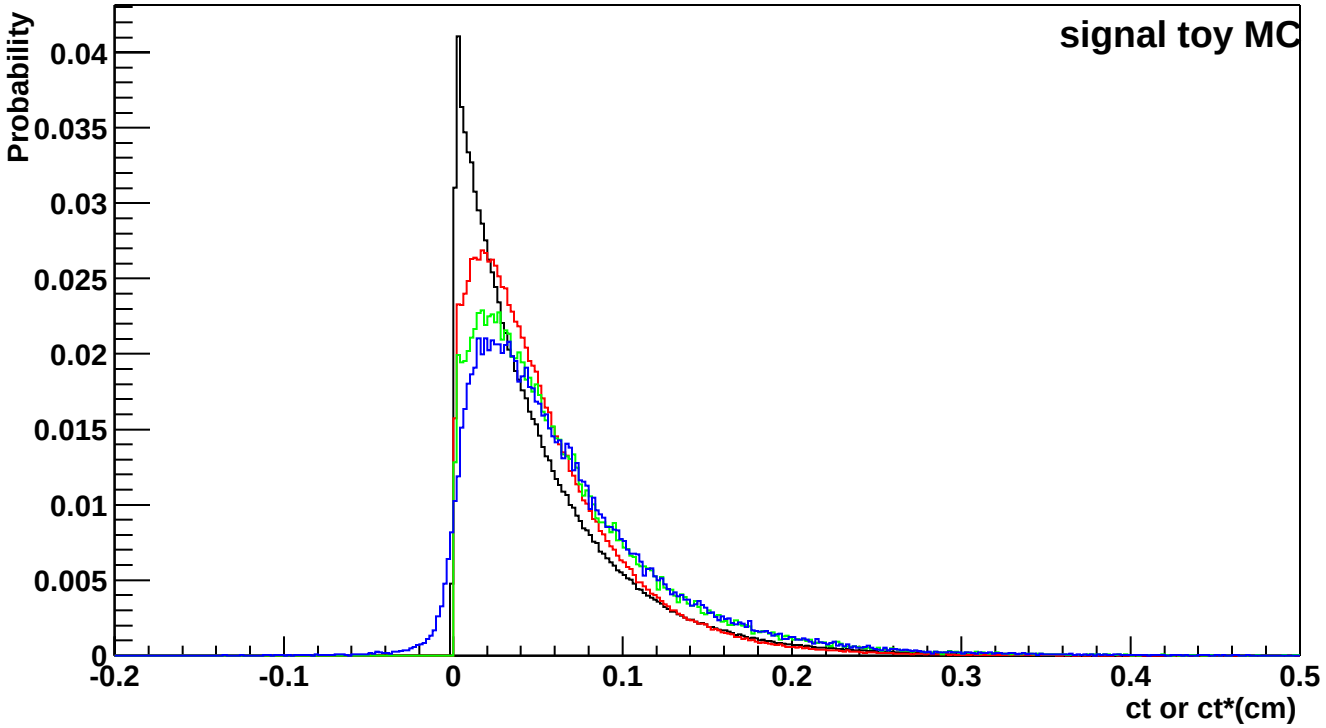

Efficiency
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0
0.1
0.2
0.3
0.4
0.5
ct (cm)
B+ -> l+ν D̄0
B+ -> l+ν D̄*0 , D̄*0 -> D̄0 X
B+ -> l+ν D̄**0 ,D̄**0 -> D̄0 X
B0 -> l+ν D*-,D*- -> D̄0 X
B0 -> l+ν D**-,D** -> D̄0 X

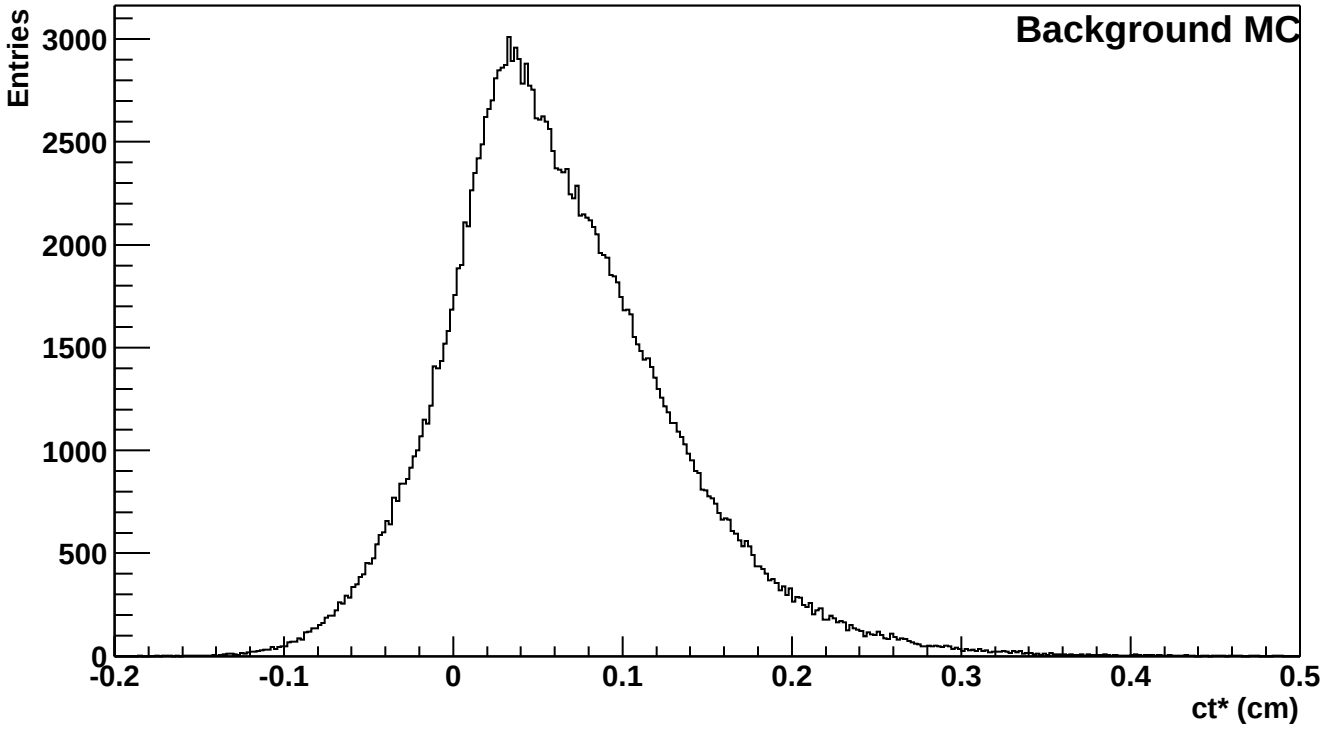

Efficiency
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0
0.1
0.2
0.3
0.4
0.5
ct (cm)
B0 -> l+ν D*-
B0 -> l+ν D**-,D**-->D*-X
B+ -> l+ν D**0,D**0->D*-X

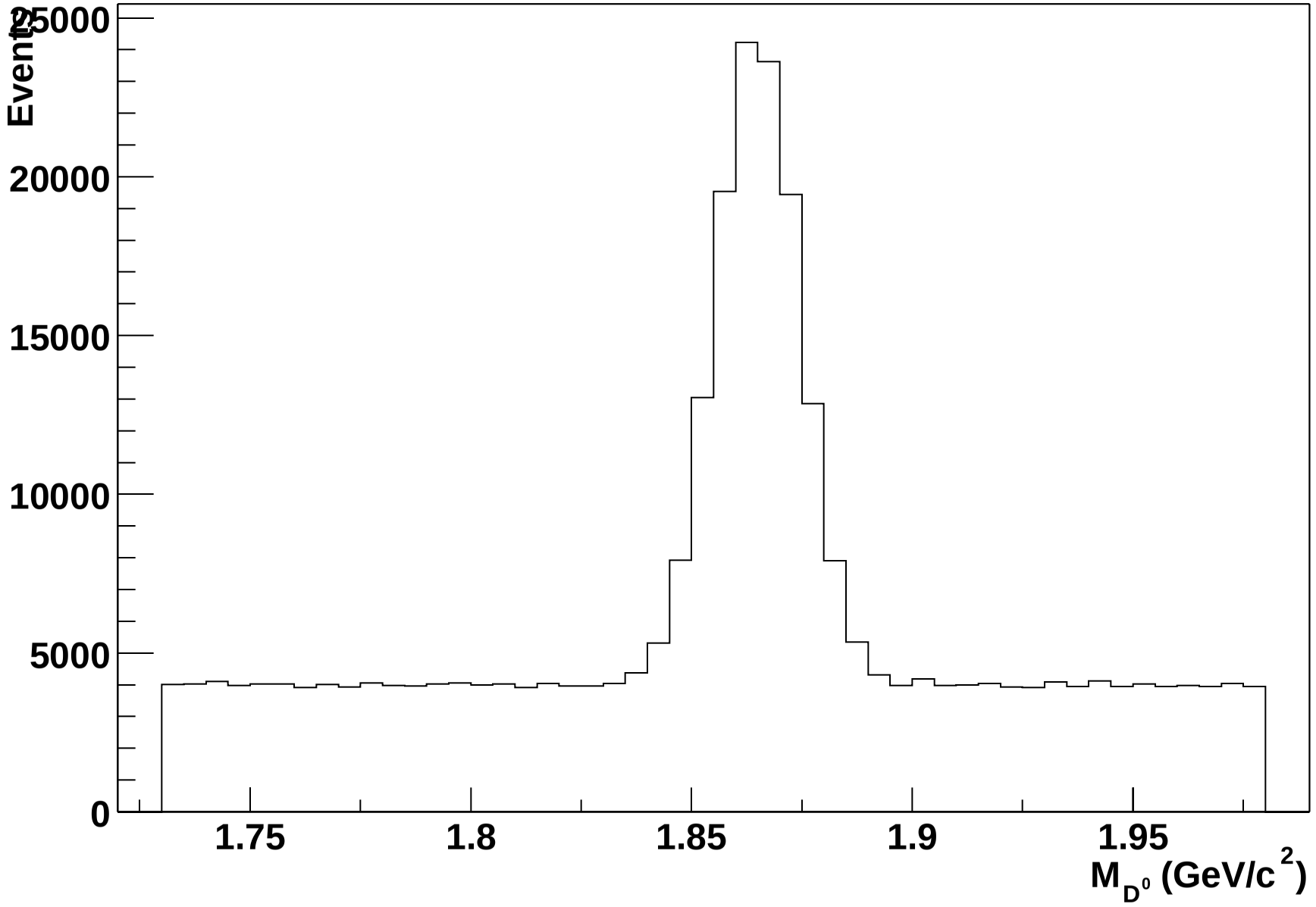

Efficiency
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
0
0.1
0.2
0.3
0.4
0.5
ct (cm)
σd0 = 0 μ m
σd0 = 40 μ m
σd0 = 60 μ m
σd0 = 80 μ m

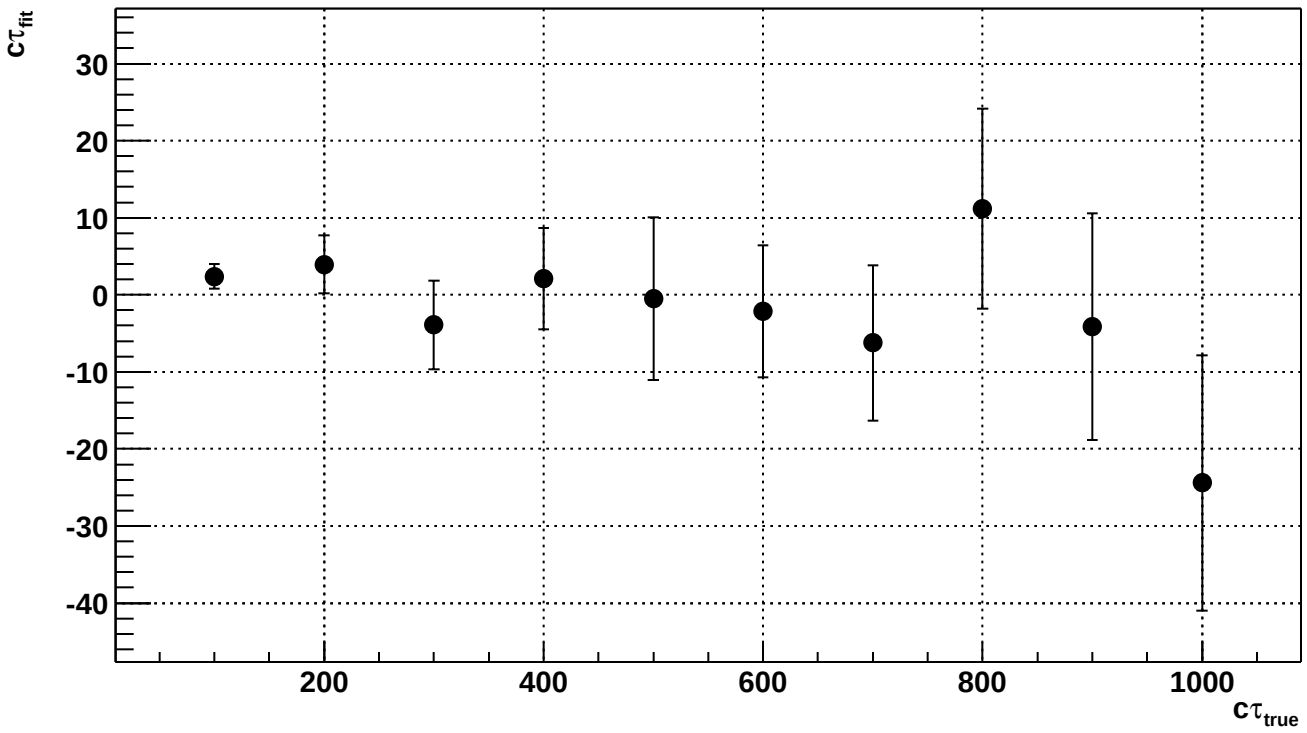

Efficiency
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
-0.01
0
0.01
0.02
0.03
0.04
0.05
0.06
0.07
ct (cm)
σd0 = 0 μ m
σd0 = 40 μ m
σd0 = 60 μ m
σd0 = 80 μ m

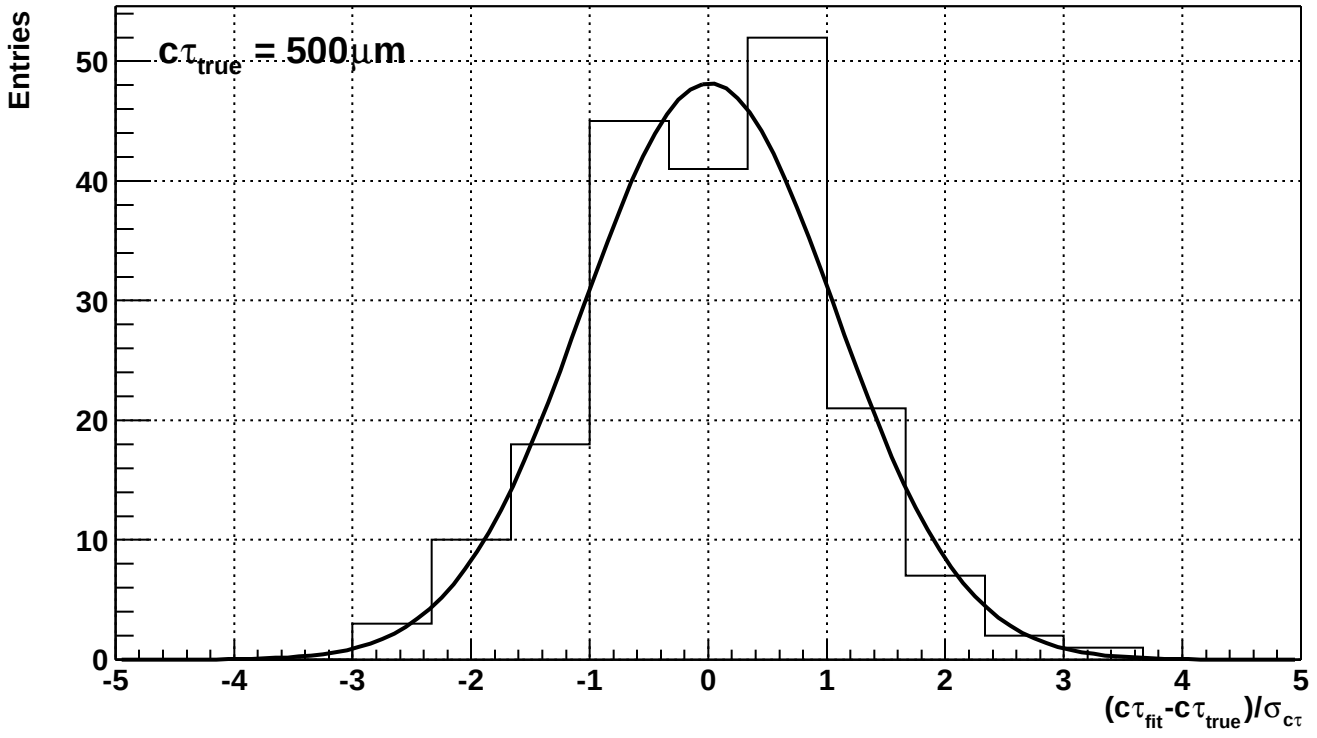

Efficiency
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
0
0.1
0.2
0.3
0.4
0.5
ct (cm)
no SVT efficiency drop against d0
SVT efficiency drop 5%/1mm
SVT efficiency drop 15%/1mm
σ_{d_0} = 60 μm


signal toy MC
Probability
0.04
0.035
0.03
0.025
0.02
0.015
0.01
0.005
0
-0.2
-0.1
0
0.1
0.2
0.3
0.4
0.5
ct or ct*(cm)


Background MC
Entries
3000
2500
2000
1500
1000
500
0
-0.2
-0.1
0
0.1
0.2
0.3
0.4
0.5
ct* (cm)


Events
25000
20000
15000
10000
5000
0
1.75
1.8
1.85
1.9
1.95
M_D0 (GeV/c^2)


$c\tau_{fit}$
30
20
10
0
-10
-20
-30
-40
200
400
600
800
1000
$c\tau_{true}$


Entries
$c\tau_{true}$ = 500μm
50
40
30
20
10
0
-5
-4
-3
-2
-1
0
1
2
3
4
5
$(c\tau_{fit}-c\tau_{true})/\sigma_{c\tau}$

Assuming σ_{d0}= 60 μm and no SVT efficiency drop against d_0, do the fit to the toy MC events ($c\tau_{true}$ = 500 μm, 100K events) generated with ...

(a) ... σ_{d0}= 60 μm, no efficiency drop
(b) ... σ_{d0}= 40 μm, no efficiency drop
(c) ... σ_{d0}= 80 μm, no efficiency drop
(d) ... σ_{d0}= 60 μm, efficiency drops
5% at d_0 = 1mm
(e) ... σ_{d0}= 60 μm, efficiency drops
15% at d_0 = 1mm

Fit results :
(a) 499.2 ± 2.3 μm
(b) 508.0 ± 2.3 μm
(c) 490.4 ± 2.3 μm
(d) 503.2 ± 2.3 μm
(e) 500.6 ± 2.3 μm

Summary

To reduce systmatics < 15 μm
from the SVT trigger bias,

- need to understand σ_{d0} of the SVT
- need to understand $\varepsilon_{SVT}(d_0)$

Plans

Study with generator-level MC
Further systematics study from,
- SVT
- bremss electron (could be change K factor)
- other possible source